Volume 12 October, 1926 *Number 10*

Lubrication

A Technical Publication Devoted to the Selection and Use of Lubricants

THIS ISSUE

Lubrication of Electric Industrial Trucks, Tractors and Hoists

PUBLISHED MONTHLY BY
THE TEXAS COMPANY, U.S.A.
TEXACO PETROLEUM PRODUCTS

What Will *Your* Industrial Truck Do When Winter Comes?

IN general, industrial transportation equipment must continue to wend its tortuous way throughout the works of industry. From building to yard, from heat treating room to stock pile, etc., perhaps to buck a snow drift now and then; later, to endure the sizzling heat of an oven.

All in the interests of increased production. For modern industry knows no brakes, not even the rigors of winter.

Conditions of this nature, however, impose the most exacting requirements upon electric truck lubricants. Winter grades cannot be used with consistency. The operating temperature range will generally be too wide.

The utmost care must therefore be taken in the selection of oils and greases which will give effective lubrication regardless of duty, operating temperatures or other intensive conditions of service.

There are TEXACO lubricants for such work. In brief, they are listed on the accompanying recommendation chart. We commend it to your careful attention and study.

Furthermore, Texaco Engineering Service is available to aid in the selection of the proper lubricants to meet any condition of operation, or the solution of any problems that may arise.

Increase your production through the practical application of Texaco Lubricants.

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Change of Address: In reporting change of address kindly give both old and new addresses.

Lubrication of Electric Industrial Trucks, Tractors and Hoists

THE handling of materials in industry is the salient factor in the attainment of maximum production. Regardless of the efficiency of operation of any particular machine, unit or department, efficient production of the plant as a whole will depend upon coordination of process work by the handling of materials to and from each stage of treatment with greatest expediency. Delay of any piece of equipment on account of faulty operation of delivering or receiving machinery such as a conveyor or electric truck will in many cases slow down production of the entire plant, or at least the particular division wherein this occurs.

In other words, the job is to keep things moving. The fact that keeping things moving involves friction renders this essentially a problem of lubrication. There is much to be said about the lubrication of materials handling machinery, such as the electric truck, not only from the view-point of improved operation, but also from the angle of economy.

Production to be a paying proposition must be carried out with the minimum of expense for the maximum of output. Expense covers not only cost of raw materials but also the cost to operate the machinery involved. This latter is normally subject to less fluctuation, covering as it does such relatively fixed items as labor, depreciation, overhead and power consumption.

It may, on the other hand be decidedly influenced by this very item of power consumption, for power consumption in its volume and cost will be directly dependent upon the intelligence of the operators, the care given to machinery and the attention which lubrication receives.

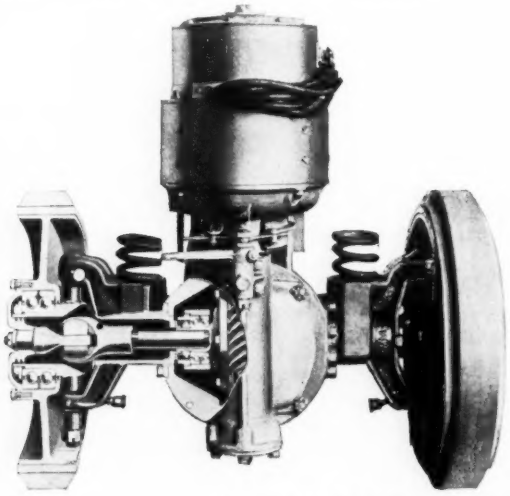
Lubrication, in fact, is the secret of economical operation of industrial plant materials handling equipment, such as the electric truck, the gas tractor, and conveyors of the belt, bucket or screw type, etc. Development of excessive friction due to faulty lubrication may so frequently slow-up production throughout the average plant, that detailed discussions will be advisable covering the essential lubricating requirements, and the nature of the lubricants that should be employed.

TRANSPORTATION EQUIPMENT

The part played by the electric industrial truck, tractor and hoist for the handling of materials in the process of production or manufacture is of decided importance. In the expediting of work within the plant, that is, from one set of machinery to another, they are especially valuable adjuncts, particularly for the transportation or lifting of heavy, bulky products. The term truck is generally applied to such a vehicle as carries its own load directly; tractor, in turn meaning a self-propelled vehicle which is used for pushing or pulling other conveyances which carry the load. As a rule a tractor will not be designed to carry any load itself.

The word truck, may mean either an electric (storage battery) driven machine or a motor truck. It is with the former, its varieties, and its several phases of lubrication that this article will have to deal.

Lubrication of such equipment can be regarded from three view-points, i.e., as involving the motor armature bearings, the final drive gears, elevating gears (where installed) and the so-called chassis parts. Essentially, the latter will include the wheel bearings, universals and steering gear parts, the brake connections and the controller elements.



Courtesy of The Elwell-Parker Electric Co.

Fig. 1—Cut-away of power axle of an electric, self-loading lift "Tructor," showing ball bearings and motor direct-connected to worm with brake between. Drive axle springs are packed with oil saturated wool waste.

Operating Range

The electric truck, tractor or hoist is an especially desirable vehicle for handling materials within buildings or over distances below about one half a mile as a maximum. Over longer distances the gas tractor or motor truck will probably function more economically than the storage battery truck. This matter of choice of vehicle for any type of hauling must be worked out on a unit cost basis per ton of materials hauled over the distances involved.

The necessity for periodic charging of storage batteries is perhaps the criterion in regard to distance hauling, for the electric industrial truck can function effectively only provided that its battery is properly charged.

While it will require an appreciable amount of time for battery re-charging, such equipment is, on the whole, economical and dependable, not subject to the vagaries of internal combustion engine operation such as difficult starting, faulty carburetion, diluted motor oils, etc., all of which may become serious detriments in cold weather.

THE POWER PLANT

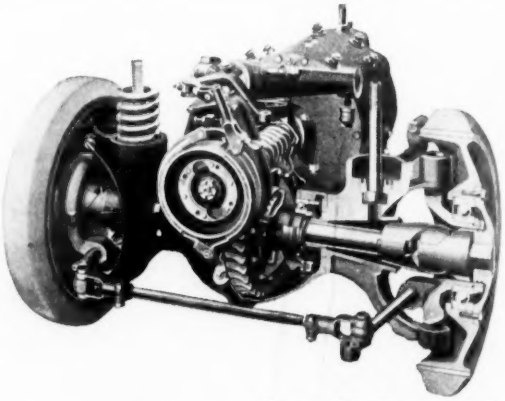
For the electric truck, etc., to function at its best it must be equipped with a motor of high starting torque, in order to insure maximum tractive effort or acceleration at lower speeds. In this connection it is of interest to know that the torque will usually vary inversely with the speed.

The fact that starting loads will frequently be high, necessitates most perfect operating conditions. Especially does this involve the matter of friction. Abnormal wear between bearings and armature journals will not only impose considerable load upon the motor, but will, as well, reduce its effective power developing capacity. Furthermore, bearing temperatures will be increased. Such conditions, unless corrected by proper lubrication will rapidly go from bad to worse, rendering the truck or hoist, as the case may be, incapable of doing the amount of work required. Ultimately, if neglected it will require overhaul, perhaps rewinding of the motor and very probably renewal of the bearings.

Electric Motor Lubrication

Motor lubrication is, therefore, most important. Anti-friction bearings will, in general, be involved according to the type of truck, the intended duty and the design of the builders.

The fact that these are the principal wearing elements involved, too frequently gives rise to the opinion that they require less than the average amount of attention. The necessity for their lubrication is appreciated by most operators, but oftentimes it is felt that this only



Courtesy of The Baker-Raulang Co.

Fig. 2—The Baker inter-standardized power axle in detail. An Oldham coupling is used between motor and worm, the latter being located above as shown. Self-aligning ball bearings carry the armature shaft.

requires the addition of "some oil" or grease now and then.

Many are prone to overlook questions such as: what this lubricant should be, the constructional details of the bearings, and the lubricating requirements imposed by virtue of the operating conditions. Perhaps this is a pardonable attitude, for the builders of electric

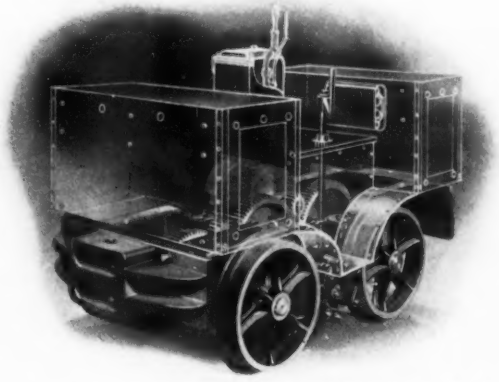
motors have given every care to the design of their bearings with a view to rendering lubrication as positive and automatic as possible.

The logical result is that the average truck operator under normal conditions of operation should experience little or no difficulty from a lubricating point of view.

On the other hand, an installation subjected to abnormal temperatures as in a heat treating plant, or exposed to dust and dirt as in a flour or cement mill may easily prove the exception to the rule. Such conditions require an intimate knowledge of the construction of the bearings involved and the extent to which oils or greases of varying characteristics can be applied in accordance with operating requirements. As a result it is absolutely essential that all concerned with electric industrial truck operation, maintenance and repair be conversant with the design and limitations of bearing lubricating systems.

Construction

The electric motor consists essentially of a frame or stationary element known as a stator, and a revolving armature called the rotor. The former contains a number of field poles suitably wound with wire, the latter is fitted with a series of coils of wire. Delivery of electric current to one or both windings brings about rotation of the armature in accordance with the law that a magnetic pole will attract



Courtesy of The Automatic Transportation Co., Inc.

Fig. 3—Phantom view of an electric industrial tractor or locomotive. Note details of drive unit and relation of gearing. Wheels are fitted with Timken tapered roller bearings.

or repel an electric conductor, such as an armature coil, in which an electric current is flowing, according to the polarity.

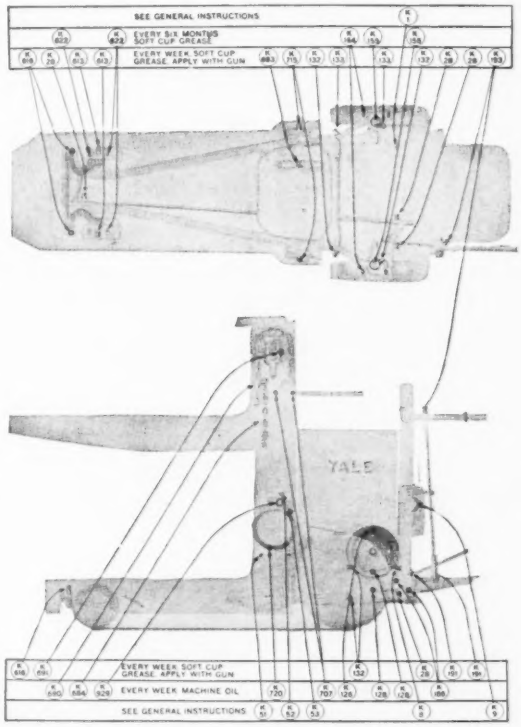
The rotor involves a central shaft or journal, which in turn must be carried in suitable bearings located in the stator or frame. These are the only wearing parts of the electric motor wherein lubrication is necessary.

THE LUBRICATING SYSTEM

Electric truck and motor builders have, of course, given care to the perfection of their lubricating systems.

Bearing Design

Anti-friction bearings have been extensively adopted, inasmuch as certain requirements



Courtesy of The Yale & Towne Mfg. Co.

Fig. 4—Lubrication chart for Model K-22 truck. Exact identity of all parts as indicated is furnished by builder on a schedule of lubrication.

such as space occupied, reduction in the amount of attention from a lubricating point of view and positiveness of action must be observed.

Ball bearings can be lubricated either with oil or light grease according to the design of the bearing housings.

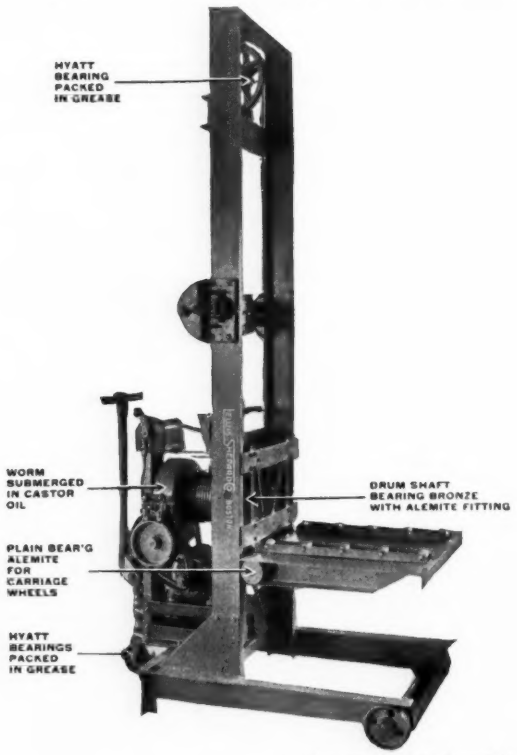
Roller bearings can be similarly lubricated though the type and construction of the rollers must be considered in addition.

Whatever their type or lubricating requirements, anti-friction bearings occupy a minimum of space, and require re-lubrication, inspection and cleaning at very infrequent intervals. The customary housing design affords ideal protection against the entry of contaminating foreign matter, and the least amount of lubricant is required for refilling.

From a constructional point of view ball and roller bearings involve rolling contact, as compared with plain bearings wherein sliding contact occurs. In ball bearings this rolling

contact is that of a theoretical point over a given surface. Roller bearings, however, involve theoretical line contact between the journal or shaft element and the outer raceway.

As is implied by their names such devices comprise a set of perfectly spherical balls or an



Courtesy of Lewis-Shepard Co.

Fig. 5—Another manner of indicating parts requiring lubrication. The above is an industrial worm drive stacker. Floor wheels are mounted on roller bearings,—to lubricate, axles must be removed.

arrangement of solid or flexible rollers. In general, the latter will be cylindrical in shape, the distance between the inner and outer raceways being uniform throughout the length of the roller. Solid rollers on the other hand may be either cylindrical or tapered according to the type and design.

Whatever the nature of the rolling elements, however, such devices, in general, must be carried or housed in much the same manner, in suitable containers comprising raceways and cages. The inner race fits on the shaft, the outer being held by the motor frame. Between them are located the balls or rollers. These are kept in their proper positions with respect to the races, and to each other, by the separator, cage, or retainer. Rotation of the shaft sets up a rotary motion between the rolling elements and the respective inner and outer surfaces of the raceways.

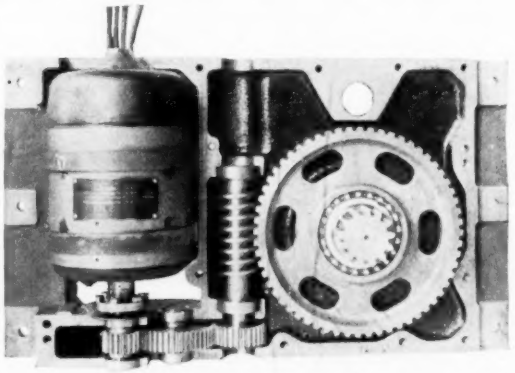
The purpose of lubrication is, therefore, to facilitate as easy rolling as possible. To enable this, however, all the surfaces (which are of a highly polished nature) must be in as perfect condition as practicable. The lubricant must therefore serve the dual purpose of both lubricating, and protecting these surfaces against rusting, corrosion, pitting or abnormal wear. Minimum clearance of course is an aid to proper functioning of such bearings, for the occurrence of any play between the component parts would tend to set up a certain amount of pounding which would be detrimental to effective operation. In other words, as nearly perfect rolling motion as possible must take place.

Selection of Lubricants

As light a lubricant should be used as can be successfully retained in such a bearing commensurate, of course, with the temperatures and pressures involved. Where an oil is desired, a product with a viscosity of from 100 to 200 seconds Saybolt at 100 degrees Fahr., will be best. Ball bearings are claimed to involve less friction to a certain extent due to the fact that there is little or no end thrust involved.

As a result the lubricant in such bearings serves more nearly the purpose of acting as a metal-protecting medium. In view of this fact, and to reduce the possibility of the development of abnormal internal friction within the lubricant, it is generally advisable to pay careful attention to the oil level.

Certain authorities contend that submergence of approximately one-half to three-



Courtesy of The Stuebing Cowan Co.

Fig. 6—Details of the elevating gears on an electric lift truck. Worm and driven gear are completely enclosed, when operating, running in a bath of oil.

quarters of the lowest ball will be sufficient. In this connection it is important to remember that contrary to the principles of plain bearing lubrication, the oil in a ball or roller bearing plays no part as a coolant. Volume is, therefore, a detriment rather than an advantage.

Importance of Pour Test

By virtue of the fact that electric truck motors may frequently be called upon to function under abnormally low temperatures, an oil with a low pour test should be chosen wherever possible. If this latter approximates Zero degrees Fahr., the oil will generally function satisfactorily. On the other hand, higher temperatures will oftentimes require additional viscosity to resist the thinning down action of heat. Under such conditions, an oil of from 300 to 400 seconds viscosity or even higher may be advisable.

Windage and Oil Spray

An important factor which requires consideration is the matter of oil finding its way into the motor. This may be due either to windage in company with the development of oil spray where the oil level is carried too high, or to the fact that the bearing housing is not oil tight. It is, of course, detrimental to the coils.

Means of Correction

To preclude the possibility of such occurrences and as well, to protect the armature coils and pole windings, it is possible to install oil baffles, throwers or labyrinth packing on the motor or inboard side of the bearing. Such devices in particular prevent direct circulation of air from the outside and through the bearing.

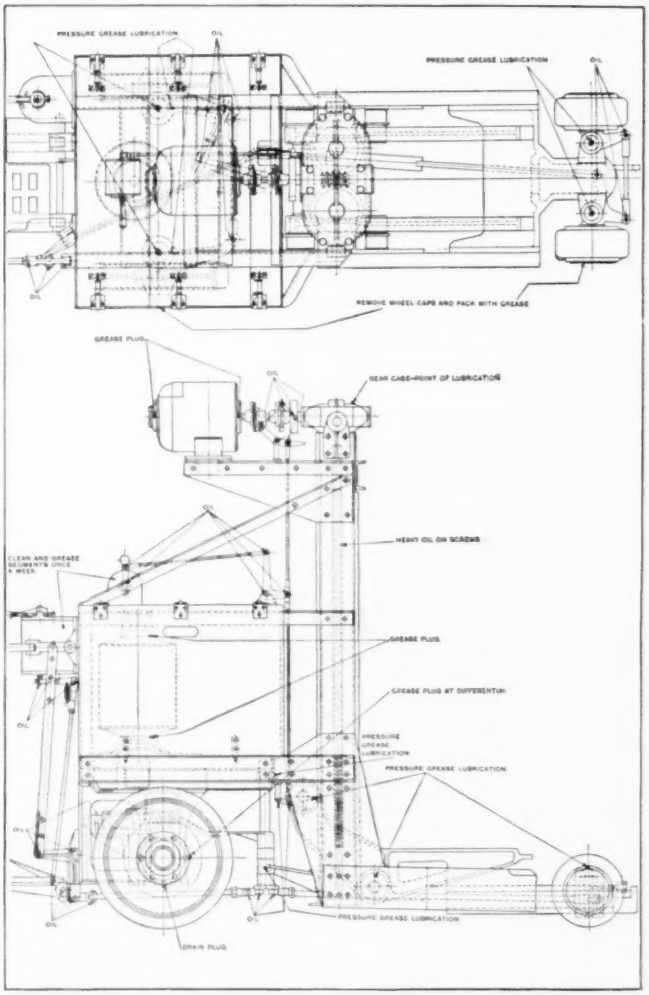
Factors Involved in Roller Bearing Lubrication

Roller bearing lubrication by means of oil is subject to much the same conditions as stated in connection with ball bearings. Where end thrust may develop to an appreciable extent, however, due to difficulty in keeping the rollers in alignment, or where pressures or temperatures may be high it is the opinion of certain authorities that it will be conducive to better lubrication if somewhat heavier oils are used. Under such conditions the use of straight mineral lubricating oils of as high as 750 seconds Saybolt viscosity at 100 degrees Fahr. are advocated. Even mineral cylinder oils of a high degree of purity may be necessary under conditions of extremely high duty, pressure or temperature.

The selection of heavier oils for roller bearing lubrication, however, should be carried out with the utmost care for it is very possible to over-estimate the conditions of operation with the result that an excess of internal friction may be developed.

When to Use Grease

Wherever there is possibility of oil leakage, however, or under conditions of dust, dirt or dampness it may be advisable to resort to grease as the lubricant. Greases furnish better seals against the entry of dust, dirt and moisture thereby serving to protect the polished surfaces of the bearing elements in a very satisfactory manner. Furthermore, grease does not settle readily to the bottom of the bearing housing when the motor is idle. There is, therefore, but little possibility of the rolling elements becoming cleared of lubricant, and exposed to the possibility of corrosion or rusting.

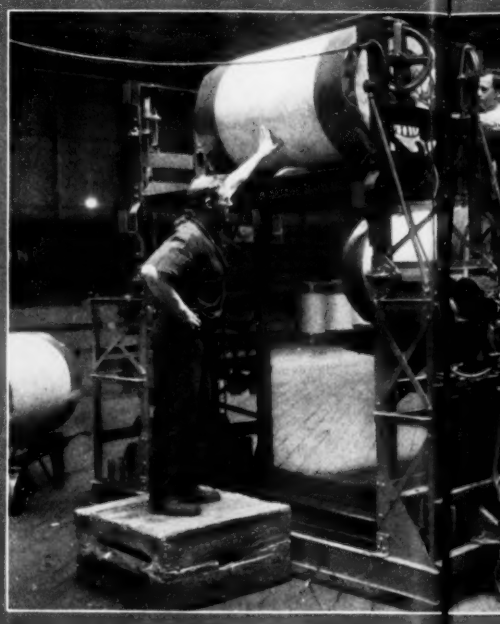


Courtesy of The Lakewood Engineering Co.

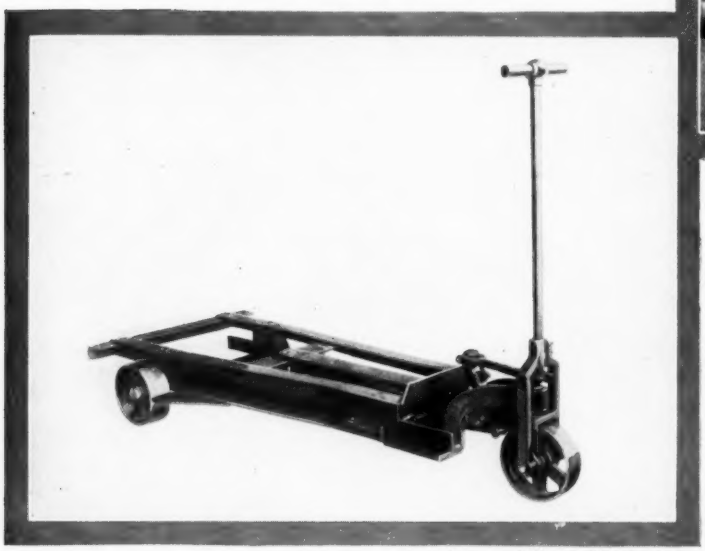
Fig. 7—Line sketch of a tier-lift truck showing in detail the parts requiring lubrication, with provisions for same, and frequency indicated. A lubrication chart of this nature is especially helpful to the operator.

Courtesy of Mercury Mfg. Co.

The old way—where a strong back counted.



The twin lift truck in action. Absolute synchronism in equipment. Loads are considerable as indicated.

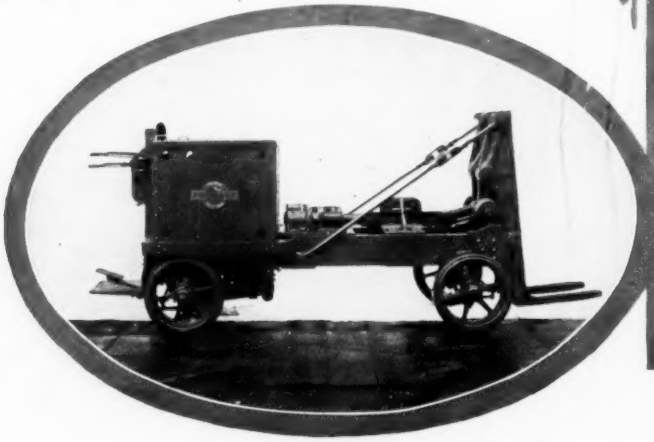


Courtesy of The Steubing Cowan Co.

A type of hand truck capable of handling up to 2½ tons. Each wheel is equipped with roller bearings.

Courtesy of Ec

The extent to which the electric tru serve as a portable ele ator is dily bro



Courtesy of Crescent Truck Co.

A type of charging truck adaptable for service in metal works and heat treating plants.

Courtesy of Economy Engineering Co.

ynchronism in raising and lowering is important on such
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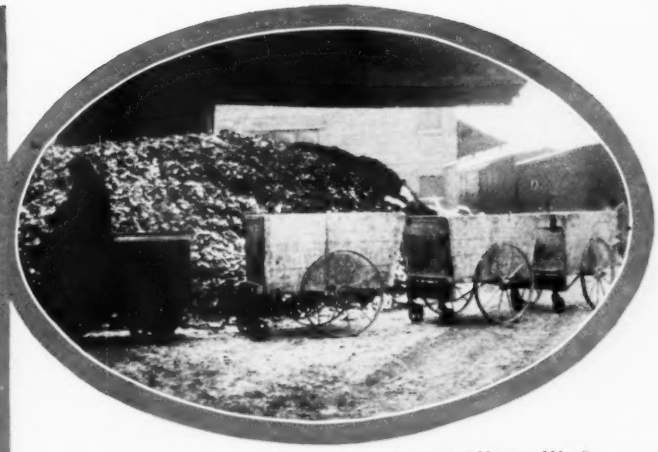
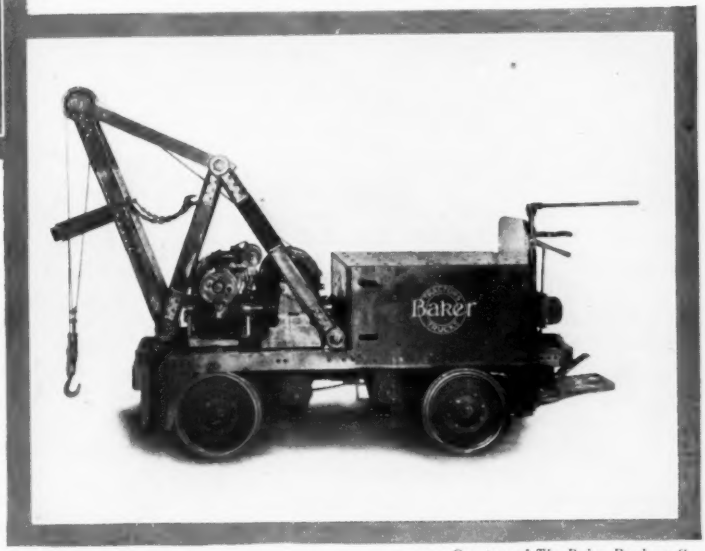


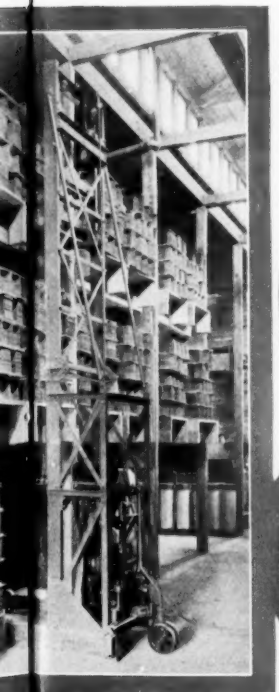
Courtesy of Mercury Mfg. Co.

The new way—where a level head counts more than a strong back.



Courtesy of The Baker-Raulang Co.

Elevation of a carrying crane. Loads up to 3,500 lbs., can be readily handled. The general all-round massiveness of construction is a point of interest.



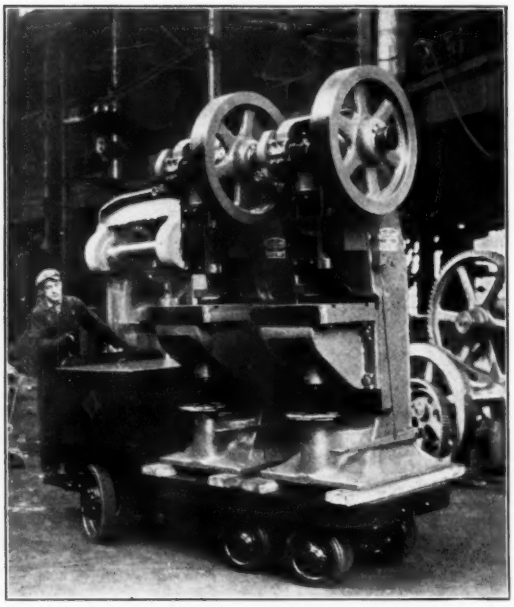
Courtesy of Economy Engineering Co.

the electric truck can be designed to
tor is readily brought out above.

Courtesy of Timken Roller Bearing Co.

Another usage for the electric truck. Elwell-Parker equipment in the railway mail service.

Grease also can be very much more effectively retained in a non-oil-tight housing. On the other hand, dirt or grit that finds its way into a grease lubricated bearing, has no means



Courtesy of The Elwell-Parker Electric Co.

Fig. 8—View of a ten-ton heavy duty truck handling a press. The necessity for rugged construction can be easily appreciated.

of settling out, but is frequently held in suspension, being carried back into the bearing repeatedly.

As a rule greases which are comparatively soft in consistency will meet average operating conditions, where the lubricant must readily cover the entire surfaces of the balls or rollers and not tend to channel in the housings or raceways, as might occur with more viscous products of this nature which would have less of a penetrative ability.

Essential Characteristics

Greases for ball and roller bearing lubrication should be as free from acid forming tendencies as possible in order to insure adequate protection of the highly polished metallic surfaces. In effect this involves perfect neutrality, and of course the absence of fillers.

The presence of any material that might give rise to oxidation, or to decomposition or settling is also prohibited.

Properly compounded products will meet these requirements satisfactorily under normal conditions of operation, and there should be practically no tendency for them to cause corrosion or pitting of balls, rollers or raceways. Every care should be observed to guard against using inferior products or greases prepared for other, more rugged service. Never use axle grease, for example, in a ball bearing.

Replenishment of Lubricant

Whatever the lubricant specified, in general, a properly designed ball or roller bearing will require replenishment of this product but once every three or four months, or oftentimes at less frequent intervals if the housing is capable of holding a relatively large volume of lubricant, and an effective seal is maintained.

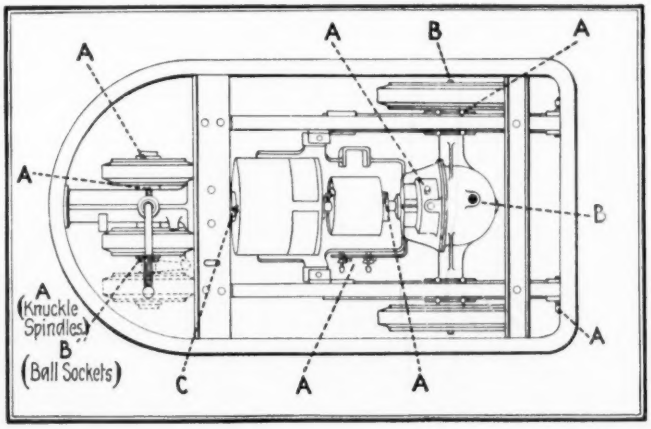
FINAL DRIVE GEARING

In contrast to the gasoline or kerosene propelled vehicle wherein both final drive and speed change gears are involved, the electric industrial truck, will require only the former or differential gears, the necessary speed changes being brought about by electric control.

Type of Axle

The geared axle of the electric truck is generally known as the power or drive axle. In many machines it is located so adjacent to the electric driving motor that a common housing will be practicable, enclosing both gearing and motor connections.

Either spur or worm gears can be used for such service, according to the type of truck, and the duty required. From the viewpoint of lubrication, conditions akin to the modern industrial reduction gear installation will prevail in many trucks, i.e., the same lubricant being required to serve both gears and bearings.



Courtesy of Mercury Mfg. Co.

Fig. 9—Plan view of lubrication chart of an electric industrial tractor. "A" indicates greasing points, pressure lubrication being provided for. "B" indicates where oil is necessary; and "C" in turn the motor armature bearings.

This also holds true for many types of gas tractors.

Lubricants for this service must, therefore, not only be of such characteristics as to adequately lubricate the bearings involved, but also capable of maintaining a suitable film, which will effectively resist the prevailing pressures on all the gear teeth.

Nature of Construction

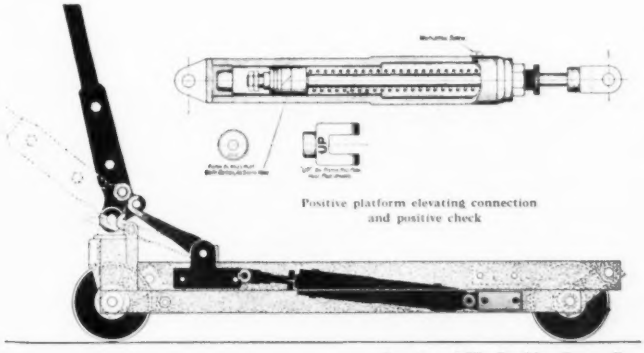
To enable proper functioning of the lubricant under such conditions of design, and to prevent undue contamination from dirt, water, or other foreign matter throughout the plant, it is customary to construct gear and motor housings of an oil-tight nature.

Considerable attention has been given to this matter of protection of lubricants and mechanical equipment. In consequence, the selection can as a rule be safely made from the viewpoint of bearing requirements and gear tooth pressures involved, provided proper attention is given to periodic renewal and draining of the gear housing to preclude contamination.

Types of Lubricants Adaptable

The lubricant best adapted to the final drive mechanisms in the average electric truck will be either a straight mineral, fluid product of comparatively high viscosity, a cold-pressed castor oil of high refinement or a light transmission grease.

The fact that certain of the bearings must be served by this same lubricant, to a more or less extent dependent upon the design, renders it imperative that comparative fluidity be a property.



Courtesy of The Steubing Cowan Co.

Fig. 10—Details of a lift truck showing the positive platform elevating connection and hydraulic safety check. This latter serves to support loads and deposit same without jar or vibration.

Were gearing alone to be involved, it might be practicable, and to good advantage oftentimes, to use a somewhat more viscous gear lubricant. The increased degree of adhesiveness obtainable would perhaps insure more positive protection of the gear teeth, with frequently greater economy.

Courtesy of The Yale & Towne Mfg. Co.

Fig. 11—Filling the gear case with lubricant on an industrial truck. Accessibility of filling plug is a factor,—entry of dirt is prevented, sloppiness is reduced and the operator is more likely to do the job carefully and thoroughly.

Renewal of Lubricant

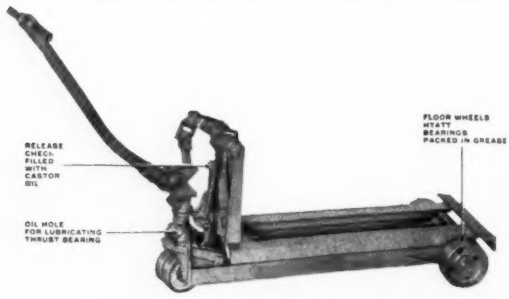
Conditions are much the same as involved in the lubrication of the differential in the modern automobile. Provided that the gear housing is capable of maintenance in sufficiently oil-tight condition to prevent leakage of the lubricant, there should not be necessity for renewal of this latter more frequently than once a month. On the other hand, frequency of renewal will depend upon the intensity or hours of operation, just as it depends upon mileage in the average automobile or tractor.

In connection with the renewal of truck and tractor gear lubricants, it is well to remember that it is not so much a matter of deterioration of these products as it is loss through leakage, or contamination by dust, dirt, or metallic particles, which requires consideration. A certain amount of foreign matter will always find its way into the gear case of the average electric truck, or be abraided from bearings and gear teeth, to eventually reduce to a marked degree, the lubricating ability of whatever product is being used.

Action of Greases

Furthermore, in the case of semi-fluid greases, or transmission lubricants which are soap-thickened oils, there will be the possibility of separation of the oil from the soap or carrier, wherever a truck must operate under

abnormally high temperature conditions. Where greases of inferior or questionable manufacture are involved this will be all the more true. Only the most careful preparation can insure against separation in a grease, when it



Courtesy of Lewis-Shepard Co.

Fig. 12—Points requiring lubrication on an industrial, hand operated jack lift truck are shown above.

must be subjected to wide variations in temperature, or lengthy storage.

For this reason soap-thickened transmission lubricants must be selected with even greater care than other products for such service. It is added proof of the advisability of at least monthly inspection of such a lubricant in the final drive housing to ascertain its ability to withstand the service involved, the possible degree of separation which may have occurred and the extent to which replenishment may be necessary.

Draining and Flushing

Approximately twice a year it will also be advisable to drain and flush the housing to completely remove all used lubricant. This will hold true regardless of the type of lubricant which is employed. The possibility of contamination with foreign matter will be the same in either case.

When draining of a power axle housing is to be carried out, it will be advisable to flush with kerosene, a light motor oil or flushing oil, after the greater part of the used lubricant has been drawn off. Flushing in this manner will insure the removal of gummed lubricant, dirt, metallic particles or any other non-lubricating matter that may have accumulated or gained entry.

Filling the Gear Housing

To avoid the possibility of leakage, or the chance of excessive power consumption by the drive, it will be well to use care and judgment in re-filling the power axle gear housing after draining. This holds true, as well, if it is necessary to add lubricant at the time of any regular monthly inspection.

As a general rule it will be the recommendation of truck builders to carry such a lubricant at the level of the filling plug or opening. Where a comparatively viscous straight mineral lubricant is used and the truck is to be operated under low temperature conditions, a noticeable decrease in pulling power will often be evident should such a lubricant be carried too high. In such cases it will frequently be advisable to carry the lubricant even below the filling plug level, especially where initial starting in a cold building, etc., may be necessary.

It is also important to note that leakage may occur in certain equipment under higher temperature operation, where the lubricant is rendered considerably more fluid than at room temperature, and where it is carried too high.

IMPORTANT CHARACTERISTICS OF SUCH LUBRICANTS

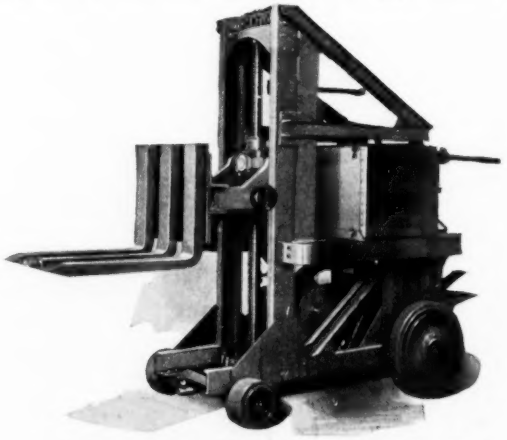
Excellent guides as to the suitability of any proposed lubricant for power axle gear housing service on the average electric industrial truck, tractor, crane or hoist are the pour test, and the viscosity at the probable temperatures of operation.

The Pour Test

Where cold weather service is probable the pour test will be decidedly important. Normally this can only be observed in a straight mineral gear lubricant or a comparatively fluid transmission grease.

Method of Test

The pour test is that temperature at which any lubricant will become so sluggish as to



Courtesy of The Automatic Transportation Co., Inc.

Fig. 13—Side view of a fork truck adaptable to handling tin plate, sheet metals, and bars without skids or platforms. This truck lifts to a maximum of 71 inches. Gear lubrication is important on this machine due to exposure and possibility of contamination of the lubricant.

cease to flow or pour. In brief, it is observed by gradually lowering the temperature of a sample at rest in a test jar, until the lubricant surrounding the bulb of a thermometer immersed therein, shall cease to flow when the test jar is tilted to a slight degree.

The pour test of any lubricant is indicative of its relative sluggishness at lower temperatures of operation. Suffice it to say that any lubricant for such service should have as low a pour test as possible.

It is for this reason that straight mineral, naphthenic base lubricants are usually advisable for low temperature service, by virtue of their relatively low pour test. Steam cylinder oils of normally equal viscosity, or semi-fluid transmission greases will in general have a considerably higher pour test or temperature of congealment.

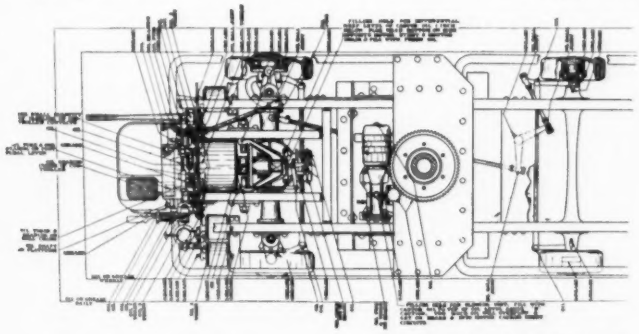
In this regard it is well to mention that there are certain semi-fluid transmission greases available which are compounded with low pour test naphthenic base oils. By reason of the normally high percentage of these latter which will be present in such lubricants the pour test of the resultant products will be materially lowered.

Probable Result of High Pour Test

The use of lubricants of too high a pour test will in all probability lead to more or less channeling in the base of the housing, under low temperature service. This will, of course, be due to the inability of such a lubricant to readily flow to its normal level around the gear teeth. As a result, in extreme cases the latter may form a veritable channel in the body of the lubricant, with ultimately the probability of the occurrence of imperfect lubrication of both gear teeth, and the bearings which should normally be served by the lubricant in the housing.

The Viscosity

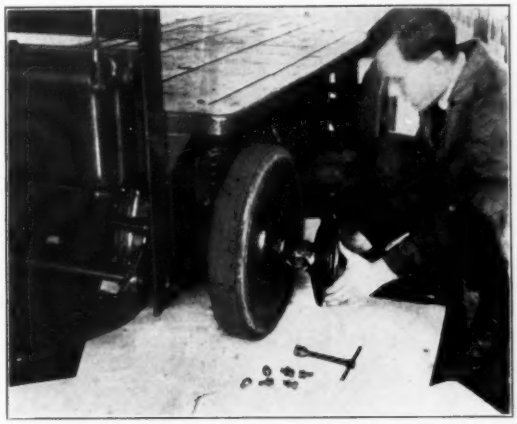
Viscosity in turn will be a valuable guide as to whether or not such a lubricant will serve its intended purpose under higher operating temperatures.



Courtesy of The Baker-Raulang Co.

Fig. 14—Plan view of an industrial truck oiling diagram, all parts being explained in detail.

Viscosity is a measure of the relative fluidity of any lubricant at whatever temperature it may be observed. Heavier bodied lubricants are usually heated to 210° Fahr. for the purpose of ready measurement of their viscosity. It is perfectly practicable, however, to convert viscosity to any desired temperature by means of a suitable temperature-viscosity chart. In other words, if a straight mineral lubricant of approximately 115 seconds Saybolt viscosity at



Courtesy of The Yale & Towne Mfg. Co.

Fig. 15—Method of lubricating and inspecting universals and wheel bearings of an electric truck.

210° Fahr. is contemplated, and it is to be used at temperatures ranging in the neighborhood of 100° Fahr. the probable operating viscosity would be from 2000 to 2500 seconds Saybolt.

Observation of the relative fluidity of such a lubricant at this temperature would give visible indication that it is of such body as to not only serve as an admirable gear lubricant, but, as well, as an excellent protective medium for the bearings.

Elevator Gears

On trucks of the hoist or lift type, involving gears for elevating purposes, the above discussion, relative to final drive gears and their lubrication, will be also applicable.

STEERING MECHANISMS, BRAKE CONNECTIONS, UNIVERSALS, WHEEL BEARINGS, ETC.

For the lubrication of all other parts of the modern industrial truck, tractor or hoist, both greases and oils of varying consistency or viscosity, are extensively used according to the type of service, constructional conditions and design of the lubricating equipment.

In effect such parts may be likened to the various chassis wearing elements on the average motor car. In other words, wheel bearings, steering mechanisms, brake lever bearings, universals, etc., will be involved as well as other parts directly pertinent to manipulation of the electric truck such as

controller shafts and drums, or switch mechanisms.

Dependent upon the nature of the above parts, grease or oil of varying characteristics, will be required. As a rule the type of lubricant will be indicated by the manufacturer on the lubrication chart of his particular truck.

In general, oil will be recommended for brake lever pins, controller shaft and spring pivot pins, switch rocker arm pins, certain steering lever pins, etc.

Grease in turn, by means of some form of positive pressure grease cup or fitting will be prescribed for controller drum shafts, steering posts, drive and trailer wheel bearings, universal joints, switch rocker arms, steering knuckles and axle springs.

In many cases, however, grease or oil of the proper characteristics will function equally well, provided that proper lubricating equipment is installed for economical and positive application of the lubricants.

It will, therefore, be advisable to discuss the principles of lubrication involved, and the characteristics of those oils or greases which will in general be essential.

The Steering Mechanism

Both oil and grease must be used for the steering gear. For example, knuckles, drag links, steering posts, and bell cranks are usually provided with means for grease lubrication. Steering posts and lever pins, etc., must in turn be oiled on many trucks. Where the lubricant must function for a considerable period of operation, where pressures may be high, or where leakage may occur, a light or medium bodied compression cup grease will in general be best for such service.

Grease applied under sufficient pressure at weekly intervals as recommended by certain prominent truck builders, by means of a pressure gun will also insure effective cleansing of the entire bearing or housing, old lubricant plus dirt, etc., being driven out as fresh lubricant is forced in.

Brake Connections

Brake connections including shoes, levers, pedals, platform shaft pin bearings, link pins, etc., should be oiled, according to most manufacturers' recommendations. These parts are much similar to the corresponding parts on the average motor car brake mechanisms, involving pin connections and plain bearing surfaces.

For these parts a medium bodied machine oil, of approximately 300 seconds Saybolt viscosity at 100° Fahr. will usually be satisfactory. Such an oil in fact is adaptable to all those external parts on the electric truck as may require periodic lubrication by means of an oil can.

Brake cam shafts, on self-loading trucks, for example, will on the other hand be frequently fitted with pressure grease fittings or grease cups. With the former, re-greasing once a week will suffice. With the latter, the cups should be given one turn daily. In both cases a light or medium cup grease should be used.

Wheel Bearings

Lubricating both drive and trailing wheel bearings with grease is practically universal in the electric truck industry today. Either ball or roller bearings are used on all the leading types of trucks to carry these wheels. While virtually oil-tight in construction, the extent of pressure involved and the necessity for continued service under frequently very exacting conditions, with assurance of an adequate seal against entry of abrasive foreign matter, has caused grease to be adopted to an almost universal degree.

For such elements a grade of light or soft grease as mentioned for electric motor bearings can be used. The frequency of application will of course depend upon the type of truck, and the design of these bearings. On some machines re-lubrication once every six months will suffice. On others, it will be necessary to remove the hub caps and pack the bearings about once a month.

Universals

Universal joints are involved on both sides of certain types of electric trucks. Frequently such joints will involve a problem of lubrication due to the rotational speeds involved, especially when they are installed on the propeller shaft. The resultant centrifugal force will often tend to throw off the lubricant from the cross pin bearings, to perhaps involve loss or waste, or at least the possibility of insufficient lubrication.

In the case of four-wheel steer trucks, however, with motor direct connected to drive worm, the universal joints are on the wheel driving shafts. Speeds here seldom exceed 100 R. P. M.

On starting either type of truck there may often be the possibility of development of abnormal pressure, the lubricant, if too light being forced out through the sealing cap or grease retainer.

For these reasons the utmost care must be observed in selecting a grease of sufficient body and adhesive characteristics to resist such effects as far as possible. A soap-thickened residual petroleum product will in general meet the requirements satisfactorily.

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